PHYSICAL CHEMISTRY

TARGET CSIR NET | IIT GATE

SOLID STATE

DPP :- 1-13

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QUANTA POINT

DPP- (1) Solid State

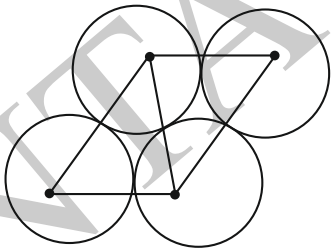
Multiple Choice Questions (MCQs)

1. Which of the following is the only incorrect statement regarding amorphous solids?
   (a) On heating, they may become crystalline at some temperature.
   (b) They may become crystalline on keeping for long time.
   (c) Amorphous solids can be moulded by heating.
   (d) They are anisotropic in nature.

2. A solid melt slightly above 273K and is a poor conductor of heat and electricity. To which of the following categories does it belong?
   (a) Ionic solid (b) Covalent solid (c) Metallic solid (d) Molecular solid

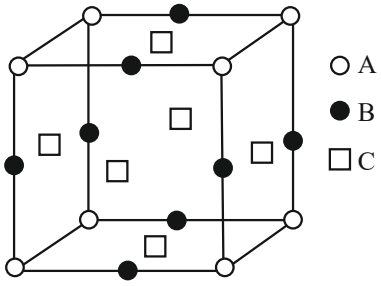
3. In a crystalline solid anions A, are arranged in CCP manner. 50% of the octahedral voids are occupied by B and 50% of the tetrahedral voids are occupied by atoms C. What is the formula of the solid?
   (a) ABC_2 (b) ABC (c) A_2BC (d) A_2BC_2

4. Radius of a triangular hole shown in the following figure in terms of radius R of the circle



   (a) 0.1547 R (b) 0.3128 R (c) 0.414 R (d) 0.2216 R

5. Given: The unit cell of structure of compound is shown below.



   The formula of compound is:
   (a) $A_8B_{12}C_5$ (b) AB_2C_3 (c) $A_2B_2C_5$ (d) ABC_5

6. In a CPS (close packed structure) of mixed oxides, it is found that lattice has O^{2-} (oxide ions), and one-half of octahedral voids are occupied by trivalent cations (A^{3+}) and one-eighth of tetrahedral voids are occupied by divalent cations (B^{2+}). Derive formula of the mixed oxide.
   (a) A_2BO_4 (b) ABO_2 (c) A_2BO_2 (d) AB_2O

QUANTA POINT

7. Consider the following facts about crystal systems.

I. The cubic systems has four three fold axes.

II. The monoclinic has one two fold axis.

III. A unit cell of a crystal system is the smallest three dimensions figure which is having the full symmertry of the crystal structure.

Select correct facts:

(a) I, II (b) I, III (c) II, III (d) I, II, III

8. A crystal is formed by two elements P and Q. The element Q forms cubic close packing and atoms of P occupy one-third of tetrahedral voids. The compound is thus represented as

(a) PQ_3 (b) P_3Q (c) P_2Q_3 (d) P_3Q_2

9. The sharp melting point of crystalline solids compared to amorphous solids is due to

(a) same arrangement of constituent particles in different directions

(b) different arrangement of constituent particles in different directions

(c) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.

(d) A regular arrangement of constitutuent particles observed over a short distance in the crystal lattice.

10. As it cools, olive oil solidfies and forms a solid over a wide range of temperature. Which term best describes the solid?

(a) Ionic (b) Covalent network (c) Metallic (d) Molecular crystal

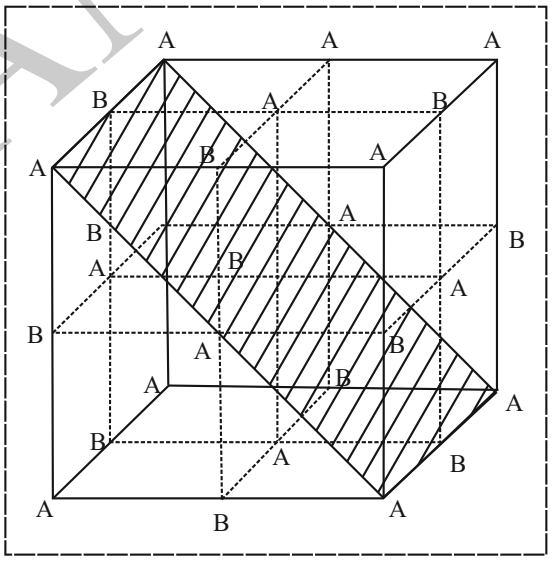
11. At low temperature, oxygen, (O_2) freezes and forms a crystalline solid. Which term best describes the solid?

(a) Covalent network (b) Molecular crystal (c) Metallic (d) Ionic

12. A crystal is made of particles X, Y and Z. X forms fcc packing. Y occupies all the octahedral voids of X and Z occupies all the tetrahedral voids of X. If all the particles along one body diagonal are removed then the formula of the crystal would be:

(a) XYZ_2 (b) X_2YZ_2 (c) $X_8Y_4Z_5$ (d) $X_5Y_4Z_8$

13. A crystal is made of particles A and B. A forms fcc packing and B occupies all the octahedral voids. If all the particles along the plane as shown in figure are removed, then, the formula of the crystal would be:



(a) AB (b) A_5B_7 (c) A_7B_5 (d) None of these

14. If the three inter-axial angles defining the unit cell are all equal in magnitude, the crystal cannot belong to the system.

(a) orthorhombic (b) hexagonal (c) tetragonal (d) cubic

QUANTA POINT

15. In a crystal, the atoms are located at the position of

(a) zero potential energy (b) infinite potential energy

(c) minimum potential energy (d) maximum potential energy

Multiple Select Questions (MSQs)

16. Which of the following can't be regarded as molecular solids?

(a) SiC (b) AlN^- (c) C (diamond) (d) Ne

17. Supercooled liquids or pseudo solids include

(a) glass (b) rubber and plastics (c) quartz glass (d) sodium chloride

Numerical Answer Type (NAT)

18. A crystal is made of particles X and Y. X forms fcc packing and Y occupies all the octahedral voids. If all the particles along one body diagonal are removed then if the formula of the crystal is X_AY_B then calculate the value of A + B

19. Calculate the number of atoms in cubic unit cell having one atom on each corner and two atoms on its each diagonal.

20. In a planar tetra-atomic molecule, XY_3, X is at the centroid of the equilateral triangle formed by the atoms, Y. If the X – Y bond distance is 1 Å, What is the distance between the centres of any two Y atoms?

QUANTA POINT

DPP-(2) Solid State

Multiple Choice Questions (MCQs)

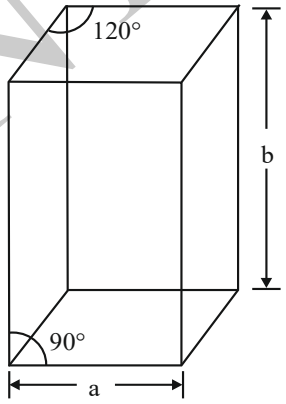
1. Which one of the following schemes of ordering closed packed sheets of equal sized spheres do not generate closest packed lattice?
   (a) ABCABC (b) ABACABAC (c) ABBAABBA (d) ABCBCABCBC

2. In a cubic unit cell, seven of the eight corners are occupied by atoms A and centres of face are occupioed by atoms B. The general formula of the compound is:
   (a) A_7B_6 (b) A_7B_{12} (c) A_7B_{24} (d) $A_{24}B_7$

3. If the anions (A) from hexagonal closest packing and cations (C) occupy only 2/3 octahedral voids in it, then the general formula of the compound is:
   (a) CA (b) CA_2 (c) C_2A_3 (d) C_3A_2

4. An alloy of copper, silver and gold is found to have copper constituting the ccp lattice. If silver atoms occupy the edge centres and gold is present at body centre, the alloy will have the formula:
   (a) Cu_4Ag_2Au (b) Cu_4Ag_4Au (c) Cu_4Ag_3Au (d) CuAgAu

5. A_2B molecules (molar mass = 259.8 g/mol) crystallises in a hexagonal lattice as shown in figure. The lattice constants were a = 5Å and b = 8Å. If density of crystal is 5 g/cm^3 then how many molecules are contained in given unit cell? (use $N_A = 6 \times 10^{23}$)



   (a) 6 (b) 4 (c) 3 (d) 2

6. Calculate has h.c.p. arrangements of carbon atoms and the parallel planes are 3.35Å apart. Determine density of graphite:
   (a) 2.46 g/cc (b) 0.4 g/cc (c) 1 g/cc (d) 1.41 g/cc

7. An element X (At. wt. = 80 g/mol) having fcc structure, calculate no. of unit cells in 8 gm of X:
   (a) $0.4 \times N_A$ (b) $0.1 \times N_A$ (c) $4 \times N_A$ (d) None of these

QUANTA POINT

8. The interstitial hole is called tetrahedral because

(a) It is formed by four spheres.

(b) Partly same and partly different.

(c) It is formed by four spheres the centres of which form a regular tetrahedron.

(d) None of the above three.

9. If the anions (A) form hexagonal closest packing and cations (C) occupy only 2/3 octahedral voids in it, then the general formula of the compound is

(a) CA (b) CA_2 (c) C_2A_3 (d) C_3A_2

10. Which one of the following schemes of ordering closed packed sheets of equal sized spheres do not generate close packed lattice.

(a) ABCABC (b) ABACABAC (c) ABBAABBA (d) ABCBCABCBC

11. The coordination number of a metal crystallising in a hcp structure is

(a) 12 (b) 4 (c) 8 (d) 6

12. A substance A_xB_y crystallises in a FCC lattice in which atoms "A" occupy each corner of the cube and atoms "B" occupy the centres of each face of the cube. Identify the correct composition of the substance A_xB_y.

(a) AB_3 (b) A_4B_3

(c) A_3B (d) composition cannot be specified

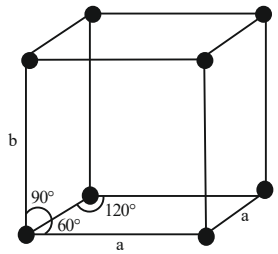
13. In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'.

The volume of this HCP unit cell is

(a) $24\sqrt{2}\,r^3$ (b) $16\sqrt{2}\,r^3$ (c) $12\sqrt{2}\,r^3$ (d) $\frac{64}{3\sqrt{3}}\,r^3$

14. Ice crystallises in a hexagonal lattice. At the low temperature at which the structure was determined, the lattice constants were a = 4.53 Å and b = 7.41 Å. How many H_2O molecules are contained in a unit cell?

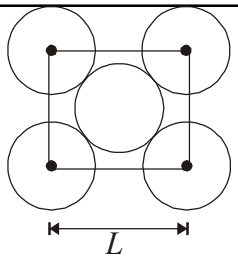
d(ice) = 0.92 g/cm^3.



(a) 2 (b) 3 (c) 4 (d) 6

15. The packing efficiency of the two-dimensional square unit cell shown below is

QUANTA POINT



(a) 39.27 % (b) 68.02 % (c) 74.05 % (d) 78.54 %

Numerical Answer Type (NAT)

16. Each void in a two dimensional hexagonal close-packed layer of circles is surrounded by

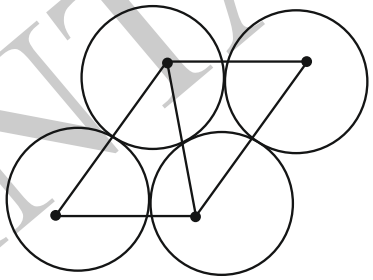
17. You are given 4 identical balls. What is the sum of maximum number of square voids and triangular voids (in separate arrangements) that can be created?

QUANTA POINT

DPP-(3) Solid State

Multiple Choice Questions (MCQs)

1. Li crystalises in bcc structure. If the edge length of unit cell is 353 pm calculate radius of Li atom.
   (a) 305.69 pm (b) 152.85 pm (c) 88.25 pm (d) 176.5 pm
2. A NH_4Cl has bcc arrangement and its unit cell edge length is 400 pm. Calculate the interionic distance in NH_4Cl.
   (a) 200 pm (b) 230.94 pm (c) 282.88 pm (d) 346.4 pm
3. Calculate the packing efficiency of sodium chloride from the following data:
   Radius of sodium ion = 0.98Å
   Radius of chloride ion = 1.81 Å
   Atomic mass of sodium = 22.99 amu
   (a) 66% (b) 74% (c) 52% (d) 34%
4. At 140K, argon is assumed to exist as solid sphere of radius 154 pm and having density 1.65 g cm^{-3}. What is the percentage of solid argon in empty space? (Argon = 40g mol^{-1})
   (a) 38% (b) 62% (c) 36% (d) 64%
5. Structure of unit cell is described in the given figure. Packing fraction of the unit cell is



   (a) 0.907 (b) 0.093 (c) 0.745 (d) 0.521
6. Sodium metal crystallises in body-centered cubic lattice with cell edge 429 pm. Thus, radius of sodium atom is
   (a) 429 pm (b) 214.5 pm (c) 186 pm (d) 152 pm
7. In an atomic bcc, what fraction of edge is not covered by atoms?
   (a) 0.32 (b) 0.16 (c) 0.134 (d) 0.268
8. The packing efficiency of a simple cubic crystal with an interstitial atom exactly fitting at the body center is:
   (a) 0.48 (b) 0.52 (c) 0.73 (d) 0.91
9. The density of solid argon (Ar = 40 g/mol) is 1.68g/mL at 40K. If the argon atom is assumed to be a sphere of radius 1.50×10^{-8} cm, what % of solid Ar is apparently empty space?
   (Use $N_A = 6 \times 10^{23}$)
   (a) 35.64 (b) 64.36 (c) 74% (d) None of these

QUANTA POINT

10. A body centred cubic lattice is made up of hollow spheres of B. Spheres of solid A are present in hollow spheres of B. Radius of A is half of radius of B. What is the ratio of total volume of spheres of B unoccupied by A in a unit cell and volume of unit cell?

(a) $\frac{7\sqrt{\pi}}{64}$ (b) $\frac{7\sqrt{3}}{128}$ (c) $\frac{7.\pi}{24}$ (d) None of these

11. Fraction of total volume occupied by atoms in a simple cube is -

(a) $\frac{\pi}{2}$ (b) $\frac{\sqrt{3}\pi}{2}$ (c) $\frac{\sqrt{2}\pi}{6}$ (d) $\frac{\pi}{6}$

12. The edge length of cube is 400 PM. Its body diagonal would be -

(a) 500 pm (b) 693 pm (c) 600 pm (d) 566 pm

13. The intermetallic compound LiAg crystallizes in cubic lattice in which both lithium and silver have coordination number of eight. The crystal class is

(a) Simple cubic (b) Body centred cubic (c) Face centred cubic (d) None

14. The mass of a unit cell of CsCl corresponds to

(a) 1 Cs^+ and 1 Cl^- (b) 1 Cs^+ and 6 Cl^- (c) 4 Cs^+ and 4 Cl^- (d) 8 Cs^+ and 1 Cl^-

15. NH_4Cl crystallizes in a body-centered cubic type lattice with a unit cell edge length of 387 pm. The distance between the oppositively charged ions in the lattice is

(a) 335.1 pm (b) 83.77 pm (c) 274.46 pm (d) 137.23 pm

Multiple Select Questions (MSQs)

16. In the cubic close packing, the unit cell has

(a) 4 tetrahedral voids each of which is shared by four adjacent unit cells

(b) 4 tetrahedral voids within the unit cell

(c) 8 tetrahedral voids each of which is shared by four adjacent unit cells

(d) 8 tetrahedral voids within the unit cell

17. An element crystallises in a 'bcc' lattice. Nearest neighbours and next nearest neighbours of the element are respectively.

(a) 8, 8 (b) 8, 6 (c) 6, 8 (d) 6, 6

Numerical Answer Type (NAT)

18. A closed packed structure of uniform spheres has the edge length of 534 pm. Calculate the radius of sphere, if it exist in BCC lattice

19. Iron has body centered cubic lattice structure. The edge length of the unit cell is found to be 286 pm. What is the radius of an iron atom?

20. In Cesium chloride structure Cesium and chloride ions are in contact along the body diagonal of the unit cell. The length of the side of the unit cell is 412 pm and Cl^- ion has a radius of 181 pm. Calculate the radius of Cs^+ ion.

QUANTA POINT

DPP-(4) Solid State

Multiple Choice Questions (MCQs)

1. Calcium crystallises in face-centred cubic unit cell with a = 0.556 nm. What fraction of Ca-atoms lie on the surface of a cubic crystal that is 1.00 cm in length?
   (a) 5.82×10^{7} (b) 2.3×10^{10} (c) 1.67×10^{-7} (d) 3.88×10^{-7}
2. Metallic magnesium has a hexagonal close-packed structure and a density of 1.74 g/cm^3. Assume magnesium atom to be sphere of radius r. 74.1% of the space is occupied by atoms. Calculate the volume of each atom (Mg = 24.3).
   (a) 1.72×10^{-23} cm^3 (b) 1.00×10^{-20} cm^3 (c) 2.32×10^{-23} cm^3 (d) 4.03×10^{-23} cm^3
3. Calculate the atomic volume (in cm^3/mol) of an element whose atoms have a radius 1.414Å when the atoms are in cubic closest packed structure.
   (a) 1.60 (b) 9.6 (c) 4.8 (d) 7.2
4. Atoms of an element are in cubic closest packed structure with radius of atom 141.4 pm. Thus, edge length of the unit cell is
   (a) 200 pm (b) 300 pm (c) 400 pm (d) 100 pm
5. The distance between an octahedral and tetrahedral void in fcc lattice would be:
   (a) $\sqrt{3}a$ (b) $\frac{\sqrt{3}a}{2}$ (c) $\frac{\sqrt{3}a}{3}$ (d) $\frac{\sqrt{3}a}{4}$
6. An element X (atomic weight = 24 gm/mol) forms a face centered cubic lattice. If the edge length of the lattice is 4×10^{-8} cm and the observed density is 2.40×10^{3} kg/m^3, then the percentage occupancy of lattice points by element X is: (Use $N_A = 6 \times 10^{23}$):
   (a) 96 (b) 98 (c) 99.9 (d) None of these
7. In a BCC packing, the nearest neighbours lie along the
   (a) edges of the cube
   (b) face diagonal
   (c) line joining the two opposite comers of the face
   (d) cube diagonal
8. Xenon crystallizes in face centre cubic lattice and the edge of the unit cell is 620 PM, then the radius of Xenon atom is -
   (a) 219.20 pm (b) 438.5 pm (c) 265.5 pm (d) 536.94 pm
9. The unit cell cube length for LiCl (NaCl structure) is 5.14 Å. Assuming anion-anion contact, calculate the ionic radius for chloride ion.
   (a) 1.815Å (b) 2.8Å (c) 3.8Å (d) 4.815Å
10. If the anions (A) form hexagonal closest packing and cations (C) occupy only 2/3 octahedral voids in it, then the general formula of the compound is

QUANTA POINT

(a) CA (b) CA_2 (c) C_2A_3 (d) C_3A_2

11. In FCC unit cell, what fraction of edge is not covered by atoms?

(a) 0.134 (b) 0.24 (c) 0.293 (d) None of these

12. Copper crystallises in fcc with a unit cell length of 361 pm. What is the radius of copper atom ?

(a) 127 pm (b) 157 pm (c) 181 pm (d) 108 pm

13. The edge length of a face centered cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is :

(a) 618 pm (b) 144 pm (c) 288 pm (d) 398 pm

14. Lithium forms body centred cubic structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be :

(a) 240 pm (b) 152 pm (c) 75 pm (d) 300 pm

15. Consider the following transition of iron at1200 K.

$$\underset{\text{bcc lattice}}{Fe(\alpha - \text{form})} \xrightarrow{1200K} \underset{\text{fcc lattice}}{Fe(\gamma - \text{form})}$$

Distance between the nearest neighbours is same in the two forms at the transition temperature 1200 K. Thus, ratio of the densitities of the two forms at 1200 K is

(a) 1.09 (b) 1.00 (c) 0.92 (d) 2.18

Multiple Select Questions (MSQs)

16. Lanthanum (La) crystallises in HCP (3D). Correct statements are

(a) The layers are in sequence of ABAB..... type.

(b) 3 atoms are presence in BC

(c) number of atoms in unit cell is 6

(d) number of atoms in unit cell is 4

17. Silicon crystallises in a unit cell similar to that of diamond (a fcc unit cell containing a tetrahedron of atoms) with a = 0.542 nm. Thus,

(a) unit cell content for Si is 8

(b) Si unit cell is predicated to be more efficiently packed that the fcc unit cell

(c) Si unit cell is predicted to the less efficiently packed that the fcc unit cell

(d) Si unit cell is packed as efficiently as fcc unit cell

Numerical Answer Type (NAT)

18. AgCl has the same structure as that of NaCl. The edge length of unit cell of AgCl is found to be 555 pm and the density of AgCl is 5.561 g cm^{-3}. Find the percentage of sites that are unoccupied.

19. As the size of largest sphere that will fit in octahedral void in an ideal FCC crystal as a function of atomic radius 'r' is 0.414r. The insertion of this sphere into void does not distort the FCC lattice. Calculate the packing fraction of FCC lattice when all the octahedral voids are filled by this sphere.

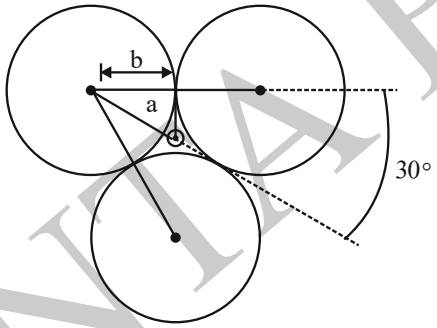
20. An element crystallises in FCC lattice having edge length 400 pm. Calculate the maximum diameter which can be placed in interstitial sites without disturbing the structure.

QUANTA POINT

DPP-(5) Solid State

Multiple Choice Questions (MCQs)

1. An element crystallises in fcc lattice having edge length 400 pm. Maximum radius of the atom which can be placed in the interstitial site without distorting the structure is
   (a) 58.55 pm (b) 117 pm (c) 166 pm (d) 83 pm
2. M^+ forms $C_{60}M_3$ where C_{60}^{3-} fulleride (a superconductor). It forms octahedral holes. If radius of C_{60}^{3-} is 500 pm, then the radius of M^+ is
   (a) 207 pm (b) 307 pm (c) 400 pm (d) 500 pm
3. The ionic radius of Mn^{2+} ion is 0.080 nm and that of S^{2-} ion is 0.184 nm. Thus, structure of the cubic unit cell of MnS is of the type
   (a) NaCl (b) ZnS (c) CsCl (d) All of these
4. The cation/anion radius ratio for a triangular arrangement of anions in which the cation is in contact with the anions (but does not push them apart) as shown in figure is



   (a) 0.866 (b) 0.414 (c) 0.155 (d) 0.500
5. If the radius of Mg^{2+} ion, Cs^+ ion, O^{2-} ion, S^{2-} ion and Cl^- ion are 0.65 Å , 1.69 Å, 1.40 Å, 1.84 Å, and 1.81 Å respectively. Calculate the co-ordination numbers of the cations in the crystals of MgS, MgO
   (a) 4 and 6 (b) 6 and 8 (c) 4 and 8 (d) 8 and 8
6. KCl crystallizes in the same type of lattice as does NaCl. Given that $\frac{r_{Na+}}{r_{Cl-}}=0.5$ and $\frac{r_{Na+}}{r_{K+}}=0.7$ Calculate. The ratio of the sides of unit cell for KCl to that for NaCl
   (a) 0.874 (b) 0.714 (c) 1.4 (d) 1.14
7. The edge length of a face centered cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is :
   (a) 618 pm (b) 144 pm (c) 288 pm (d) 398 pm
8. KCl crystallizes in the same type of lattice as does NaCl. Give that $r_{Na^+} / r_{Cl^-} = 0.50$ and $r_{Na^+} / r_{K^+} = 0.70$, calculate the ratio of the side of the unit cell for KCl to that for NaCl:
   (a) 1.143 (b) 1.224 (c) 1.414 (d) 0.875
9. A compound XY crystallizes in BCC lattice with unit cell edge length of 480 pm. If the radius of Y^- is 225 pm, then the radius of X^+ is

QUANTA POINT

(a) 127.5 pm (b) 190.68 pm (c) 225 pm (d) 255 pm

10. An ionic compound AB has ZnS type structure. If the radius A^+ is 22.5 pm, then the ideal radius of B^- would be
(a) 54.35 pm (b) 100 pm (c) 145.16 pm (d) none of these

11. Copper metal crystallizes in BCC lattice. Edge length of unit cell is 362 pm. The radius of largest atom that can fit into the voids of copper lattice without disturbing it.
(a) 53 pm (b) 45 pm (c) 93 pm (d) 60 pm

12. The two ions A^+ and B^- have radii 88 and 200 pm respectively. In the closed packed crystal of compound AB, predict the co-ordination number of A^+.
(a) 4 (b) 6 (c) 8 (d) 12

13. In Cesium chloride structure Cesium and chloride ions are in contact along the body diagonal of the unit cell. The length of the side of the unit cell is 412 pm and Cl^- ion has a radius of 181 pm. Calculate the radius of Cs^+ ion.
(a) 175.8 pm (b) 152.6 pm (c) 121.16 pm (d) 104.98 pm

14. A solid A^+ and B^- had NaCl type closed packed structure. If the anion has a radius of 250 pm, what should be the ideal radius of the cation?
(a) 54.35 pm (b) 103.4 pm (c) 141.164 pm (d) 225.6 pm

15. The edge of the length of the NaCl unit cell is ..... if radius of Na^+ is 97 pm and radius of Cl^- is 181 pm.
(a) 556 pm (b) 278 pm (c) 139 pm (d) 120 pm

Multiple Select Questions (MSQs)

16. The radius of a divalent cation M^{2+} is 94 pm and of divalent anion X^{2-} is 146 pm. Thus, structure of M^2X^{2-} cannot be
(a) rock salt (NaCl) structure (b) zinc blende structure
(c) antifluorite structure (d) bcc (CsCl) structure

17. The unit cell of ammonium chloride is smaller to the unit cell of CsCl. Given, $r(Cl^-) = 0.181$ nm, then $r(NH_3^+)$ cannot lies in the range of
(a) 0.132 – 0.181 nm (b) 0.075 – 0.132 nm (c) 0.040 – 0.075 nm (d) 0.225 – 0.414 nm

Numerical Answer Type (NAT)

18. The two ions A^+ and B^- have radii 88 and 200 pm respectively. In the close packed crystal in of compound AB, predict the co-ordination number of A^+.

19. Br^- ions from a close packed structure. If the radius of Br^- ion is 195 pm, calculate the radius of the cation that just fits into the tetrahedral hole.

20. Radii of A^+ and that of X^- and Y^- have been given as:

A^+	1.00pm
X –	1.00pm
Y –	2.00pm

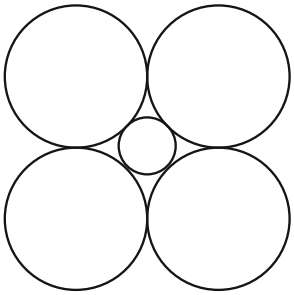
Determine volume of the unit cell of AY crystals.

QUANTA POINT

DPP-(6) Solid State

Multiple Choice Questions (MCQs)

1. The edge length of the unit cell of LiCl(NaCl-like structure, fcc) is 5.14Å. Assuming that the lithium ion is small enough that the chloride ions are in contact, calculate the ionic radius for the chloride ions.



(a) 3.63 Å (b) 2.57 Å (c) 2.14 Å (d) 1.81 Å

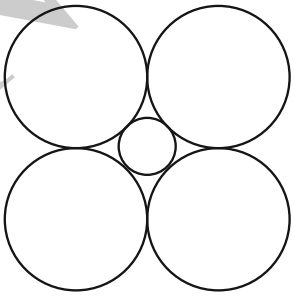
2. The density of CsBr with bcc structure is 4.4 g/cm^3. Calculate the interionic distance in crystals of CsBr (M = 213 g mol^{-1}).

(a) 471 pm (b) 544 pm (c) 373 pm (d) 285 pm

3. Number of formula units in unit cells of MgO (rock salt) ZnS (zinc blende) and Pt (fcc) are respectively

(a) 4, 3, 2 (b) 4, 3, 4 (c) 4, 4, 4 (d) 4 , 3, 1

4. LiCl has NaCl type structure with edge length 514 pm. Assuming that the Li^+ ion is smaller enough that the chloride ions are in contact, then radius of Cl^- ion is



(a) 257 pm (b) 182 pm (c) 364 pm (d) 223 pm

5. How many unit cell are present in 4.0gm of crystal AB (formula mass of AB = 40) having rock salt type structure? (N_A = Avogadro's no.)

(a) N_A (b) $\frac{N_A}{10}$ (c) $4N_A$ (d) None of these

6. The density of CaF_2(fluorite structure) is 3.18g/cm^3. The length of the side of the unit cell is:

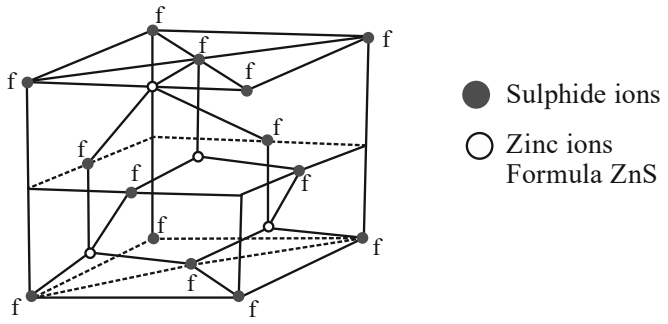
(a) 253 pm (b) 344 pm (c) 546 pm (d) 273 pm

7. Rubidium bromite crystallises as NaCl type lattice. Each unit length of Rb^+ ion is 30 pm greater than that of K^+ ion of the same halide. Calculate ionic radius of Rb^+? (r_{K^+} = 133 pm)

QUANTA POINT

(a) 203 pm (b) 143 pm (c) 287 pm (d) 234 pm

8. Look at the zinc blende (ZnS) structure in the given figure. What are the number of zinc and sulphide ions in one unit cell?



The zinc blende structure

(a) 4 and 4 (b) 4 and 8 (c) 8 and 4 (d) 8 and 8

9. In the cubic crystal of CsCl(d = 3.97 g cm^{-3}) the eight corners are occupied by Cl^- ions with a Cs^+ at the centre neighbouring Cs^+ and Cl^- ions. What is the radius ratio of two ions?

(a) 0.41 (b) 0.225 (c) 0.73 (d) 1

10. A crystal of lead (II) sulphide has NaCl structure. In this crystal the shortest distance between a Pb^{2+} ion and S^{2-} ion is 297 pm. What is the volume of unit cell in lead sulphide?

(a) 209.6×10^{-24} cm^3 (b) 207.8×10^{-23} cm^3 (c) 22.3×10^{-23} cm^3 (d) 209.8×10^{-23} cm^3

11. Select right expression for determining packing fraction (P.F.) of NaCl unit cell (assume ideal), if ions along an edge diagonal are absent:

(a) $\text{P.F.} = \dfrac{\frac{4}{3}\pi(r_+^3 + r_-^3)}{16\sqrt{2}r_-^3}$ (b) $\text{P.F.} = \dfrac{\frac{4}{3}\pi\left(\frac{5}{2}r_+^3 + 4r_-^3\right)}{16\sqrt{2}r_-^3}$

(c) $\text{P.F.} = \dfrac{\frac{4}{3}\pi\left(\frac{5}{2}r_+^3 + r_-^3\right)}{16\sqrt{2}r_-^3}$ (d) $\text{P.F.} = \dfrac{\frac{4}{3}\pi\left(\frac{7}{2}r_+^3 + r_-^3\right)}{16\sqrt{2}r_-^3}$

12. How many effective Na^+ and Cl^- ions are present respectively in a unit cell of NaCl solid (Rock salt structure) if all ions along line connecting opposite face centres are absent?

(a) 3, 3 (b) $\frac{7}{2}, 4$ (c) $\frac{7}{2}, \frac{7}{2}$ (d) $4, \frac{7}{2}$

13. Caesium chloride, on heating, changes into

(a) CsCl(g) (b) NaCl structure

(c) antifluorite structure (d) Zns structure

14. BaO has a rock salt type structure. When subjected to high pressure, the ratio of the coordination number of Ba^{2+} ion to O^{2-} ion changes to

(a) 4 : 8 (b) 8 : 4 (c) 8 : 8 (d) 4 : 4

15. In Na_2O structure

(a) O^{2-} ions constitute CCP and Na^+ ions occupy all the octahedral holes

(b) O^{2-} ions constitute CCP and Na^+ ions occupy all the tetrahedral holes

(c) O^{2-} ions constitute CCP and Na^+ ions occupy 50% of tetrahedral holes and 100% octahedral holes

(d) Na^+ ions constitute CCP and O^{2-} ions occupy half of octahedral holes

QUANTA POINT

Multiple Select Questions (MSQs)

16. Which of the following statement(s) is/are correct?

(a) The CN of each type of ion in CsCl crystal is 8

(b) A metal that crystallises in bcc structure has a CN of 12

(c) A unit cell of an ionic crystal shares some of its ions with other unit cells

(d) The length of the unit cell in NaCl is 552 pm

(r_{Na^+} = 95 pm; r_{Cl^-} = 181 pm).

17. Select the correct statement(s) about $\gamma\left(=\frac{r_+}{r_-}\right)$

(a) A CsCl structure is expected when , $\gamma > \sqrt{3}-1$

(b) A rock salt structure is expected when, $\gamma > \sqrt{2}-1$

(c) A rock salt structure is expected when, $\gamma < \sqrt{3}-1$

(d) All of the above

Numerical Answer Type (NAT)

18. A binary solid ($A^+ B^-$) has a rock salt structure. If the edge length is 400 pm and radius of cation is 75 pm, the radius of anion is

19. MgO exists in a rock salt type unit cell. Each Mg^{2+} ion will be in contact with

20. Sodium oxide has anti-fluorite structure. The percentage of the tetrahedral voids occupied by the sodium ions is

QUANTA POINT

DPP- (7) Solid State

Multiple Choice Questions (MCQs)

1. Calculate the density of silver which crystallizes in the face-centred cubic structure. The distance between the nearest silver atoms in the structure is 287 pm. Molar mass of Ag = 107.87g mol^{-1}, $N_A = 6.022 \times 10^{23}$ mol^{-1}.
   (a) 10.706 g cm^{-3} (b) 1.0706 g cm^{-3} (c) 10.706 g m^{-3} (d) 1.0706 g m^{-3}
2. Cr has monoatomic body centred-cubic structure. Its edge length is 300 pm. What is its density?
   [Atomic mass of Cr = 52 g mol^{-1}, $N_A = 6.023 \times 10^{23}$]
   (a) 5.206 g cm^{-3} (b) 10.502 g cm^{-3} (c) 6.396 g cm^{-3} (d) 4.125 g cm^{-3}
3. An element (atomic mass = 60) having face centred cubic structure has a cell edge of 400 pm. What is its density?
   (a) 10.901 g cm^{-3} (b) 4.206 g cm^{-3} (c) 3.102 g cm^{-3} (d) 6.227 g cm^{-3}
4. The edge length of NaCl unit cell is 564 pm. What is the density of NaCl in g cm^{-3} ?
   (a) 1.90 g cm^{-3} (b) 2.166 g cm^{-3} (c) 4.502 g cm^{-3} (d) 3.002 g cm^{-3}
5. The compound CuCl has ZnS structure and the edge length of unit cell is 500 pm. Calculate its density. [Atomic mass of Cu = 63, Cl = 35.5]
   (a) 5.234 g cm^{-3} (b) 5.234 kg cm^{-3} (c) 5.234 g m^{-3} (d) 5.234 kg m^{-3}
6. Determine the type of cubic lattices to which iron crystal belongs if its cell has an edge length of 286 pm and the density of iron crystal is 7.86 g cm^{-3}. [Fe = 56 g mol^{-1} $N_A = 6.023 \times 10^{23}$]
   (a) FCC (b) SCC (c) DCC (d) BCC
7. Sodium crystallizes in the cubic lattice and the edge of the unit cell is 430 pm. Calculate the number of atoms in a unit cell. [Na = 23 amu, density of sodium = 0.9623 g cm^{-3}, $N_A = 6.023 \times 10^{23}$ mol^{-1}]
   (a) 1 (b) 2 (c) 4 (d) 6
8. An element exists in bcc structure with a cell edge of 288 pm. If the density of the element is 7.2 g cm^{-3}, What is atomic mass of the element?
   (a) 52 g mol^{-1} (b) 81 g mol^{-1} (c) 79 g mol^{-1} (d) 98 g mol^{-1}
9. An element has bcc structure. It has a cell edge length of 250 pm. Calculate its molar mass if its density is 8.0 g cm^{-3}.
   (a) 42 g mol^{-1} (b) 35 g mol^{-1} (c) 38 g mol^{-1} (d) 76 g mol^{-1}
10. Copper crystallizes in face centred cubic lattice and has a density of 8.93 g cm^{-3} at 293 K. Calculate the radius of copper atom.
    (a) 127.82 m (b) 127.82 nm (c) 127.82 cm (d) 127.82 pm
11. Crystalline CsBr has a cubic structure. Calculate the unit cell edge length if the density of CsBr crystal is 4.24 g cm^{-3}. [Cs = 133, Br = 80 amu]
    (a) 436 pm (b) 4.36 pm (c) 436 nm (d) 4.36 nm

QUANTA POINT

12. An element of atomic mass 98.5 g mol^{-1} occurs in fcc structure. If its unit cell edge length is 500 pm and its density is 5.22 g cm^{-3}. What will be the value of Avogadro's constant?
(a) 6.038×10^{23} mol^{-1} (b) 6.038×10^{22} mol^{-1} (c) 6.038×10^{21} mol^{-1} (d) 6.038×10^{20} mol^{-1}

13. First three nearest neighbour distances for primitive cubic lattice are respectively (edge length of unit cell = a):
(a) $a, \sqrt{2}a, \sqrt{3}a$ (b) $\sqrt{3}a, \sqrt{2}a, a$ (c) $a, \sqrt{2}a, 2a$ (d) $a, \sqrt{3}a, 2a$

14. First three nearest neighbour distances for body centred cubic lattice are respectively:
(a) $\sqrt{2}a, a, \sqrt{3}a$ (b) $\frac{a}{\sqrt{2}}, a, \sqrt{3}a$ (c) $\frac{\sqrt{3}a}{2}, a, \sqrt{2}a$ (d) $\frac{\sqrt{3}a}{2}, a, \sqrt{3}a$

15. Xenon crystallises in the face centred cubic lattice and the edge of the unit cell is 620 pm. What is the nearest neighbour distance
(a) 219.25 pm (b) 438.5 pm (c) 310 pm (d) 253 pm

Multiple Select Questions (MSQs)

16. The current statement regarding the density of lattice is/are:
(a) maximum density possible in structures of spheres of only one size is 74.05%.
(b) In ccp structure, maximum density possible is 74.05.
(c) In non-cp structure, densities greater than 0.74 are obtained.
(d) In non-cp structure, densities lower than 0.74 are obtained.

17. Which of the following are correct about voids formed in three-dimensional hexagonal close-packed structure?
(a) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer
(b) All the triangular voids are not covered by the spheres of the second layer.
(c) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular shapes of these voids do not overlap
(d) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

Numerical Answer Type (NAT)

18. Metallic gold crystallizes in a fcc lattice and has a density of 19.3 g cm^{-3}. Calculate the radius of gold atom.

19. An element has bcc structure. It has a cell edge length of 250 pm. Calculate its molar mass if its density is 8.0 g cm^{-3}.

20. PbS has NaCl type structure. What is its density? The edge length of the unit cell of PbS is 500 pm.
[$N_A = 6.023 \times 10^{23}$, Pb = 207.2, S = 32 amu]

QUANTA POINT

DPP-(8) Solid State

Multiple Choice Questions (MCQs)

1. The density of a pure substance 'A' whose atoms are in cubic close pack arrangement is 1 g/cc. If all the tetrahedral voids are occupied by 'B' atom, what is the density of resulting solid in g/cc. [Atomic mass (A) = 30 g/mol and atomic mass (B) = 50 g/mol]

   (a) 3.33 (b) 4.33 (c) 2.33 (d) 5.33

2. Sodium (Na = 23) crystallizes in bcc arrangement with the interfacial separation between the atoms at the edge of 53.6 pm. The density of sodium crystal is:

   (a) 2.07 g/cc (b) 2.46 g/cc (c) 1.19 g/cc (d) None of these

3. When heated above 916°C, iron changes its bcc crystalline form to fcc without the change in the radius of atom. The ratio of density of the crystal before heating and after heating is:

   (a) 1.069 (b) 0.918 (c) 0.725 (d) 1.231

4. A crystal plane intercepts the three crystallographic axes at a, $\frac{1}{2}$ b and $\frac{3}{2}$ c where a; b and c are the unit length along X, Y and Z axes respectively. What are the Miller indices of this plane?

   (a) (123) (b) (362) (c) (123/2) (d) (263)

5. Calculate the Miller indices of crystal plane which cut through the crystal axes at 2a, –3b, –3c.

   (a) (322) (b) (233) (c) $(3\bar{2}\bar{2})$ (d) $(2\bar{3}\bar{3})$

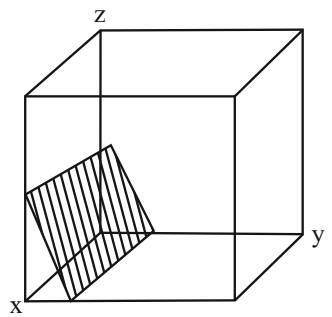
6. A plane makes intercepts 1, 2 and 0.5Å on the crystallographic axes of an orthorhombic crystal with a : b : c = 3 : 2 : 1. Determine the Millar indices of this plane.

   (a) (312) (b) (321) (c) (123) (d) (133)

7. In a cubic unit cell, find the angle between normal's to the planes (111) and (121).

   (a) 19°28′ (b) 32°28′ (c) 45° (d) 65°37′

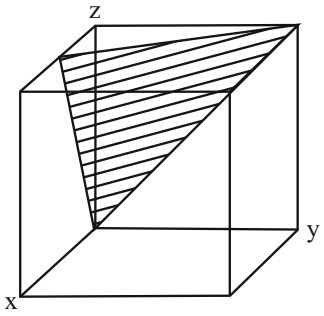
8. What is the Miller indices of given plane



QUANTA POINT

(a) [2 1 $\bar{1}$] (b) [$\bar{2}$ 2 3] (c) [0 3 2] (d) [0 1 $\bar{2}$]

9. What is the Miller indices of given plane



(a) [1 0 $\bar{2}$] (b) [$\bar{1}$ 0 $\bar{2}$] (c) [0 2 3] (d) [2 1 1]

10. Crystal A diffracts from (111) and (200) planes but not from (110) plane, while the crystal B diffracts from (110) and (200) planes but not from the (111) plane. From the above, we may conclude that

(a) A has fcc lattice while B has bcc lattice

(b) A has bcc lattice while B has fcc lattice

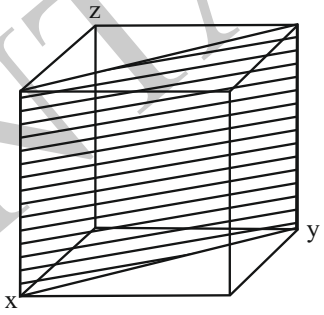
(c) A and B both have fcc lattice

(d) A and B both have bcc lattice

11. For a simple cubic crystal, X-ray diffraction shows intense reflections for angle θ_1 and θ_2 which are assigned to [1 0 1] and [1 1 1] planes, respectively. The ratio $\theta_1/\sin\theta_2$ is

(a) 1.5 (b) 1.22 (c) 0.82 (d) 0.67

12. What is the Miller indices of given plane



(a) [1 1 0] (b) [1 0 1] (c) [2 1 3] (d) None

13. Which of the following does not come in the family of < 100 >

(a) [1 0 0] (b) [$\bar{1}$ 0 0] (c) [1 1 0] (d) [0 0 1]

14. Which of the following comes under family of < 111 > ?

(a) [1 1 1] (b) [1 1 $\bar{1}$] (c) [$\bar{1}$ $\bar{1}$ 0] (d) all of these

15. Calculate the angle between [11 $\bar{1}$] and [$\bar{1}$ $\bar{1}$ $\bar{1}$] directions in a cubic crystal.

(a) 90° (b) 180º (c) 107° (d) 121°

16. Find the miller indices of a plane that makes intercepts on a, b and c axis equal to 3Å, 4Å and 3Å in a tetragonal crystal with c/a ratio as 1.5?

(a) (236) (b) (123) (c) (436) (d) (343)

Multiple Select Questions (MSQs)

17. Draw (101) and (111) planes in a cubic unit cell and determine the Miller indices of the directions which are

QUANTA POINT

common to both the planes.

(a) $(\bar{1}01)$ (b) $(10\bar{1})$ (c) $(11\bar{1})$ (d) $(\bar{1}10)$

Numerical Answer Type (NAT)

18. In a tetragonal crystal, the lattice parameters a = b = 2.42Å and c = 1.74Å. Find the interplanar spacing between consecutive (101) planes?

19. The angle between [111] and $[\bar{1}\bar{1}1]$ direction in a cubic crystal is

20. The angle between the two planes represented by the Miller indices (1 1 0) and (1 1 1) in a simple cubic lattice is:

QUANTA POINT

DPP-(9) Solid State

Multiple Choice Questions (MCQs)

1. Calculate the angle at which second-order reflection will occur in an X-ray spectrometer when X-rays of 0.154 nm are diffracted by the atoms of a crystal having distance between two planes as 404 pm.
   (a) 30° (b) 45° (c) 22° (d) 60°
2. When an electron in an excited Mo-atom falls from L to K-shell, an X-rays is emitted. These X-rays are diffracted at an angle of 7.75° by planes with a separation of 264 pm. Thus, difference in energy between K-shell and L-shell in Mo, assuming a first-order diffraction, is (sin 7.75° = 0.135)
   (a) 27.86×10^{-16} J (b) 3.59×10^{14} J (c) 1.675×10^{9} J (d) None of the above
3. The diffraction of barium with X-radiations of wavelength 229 pm gives a first-order diffraction at an angle of 30°. What is the distance between diffracted planes.
   (a) 229 pm (b) 429 pm (c) 352 pm (d) 127 pm
4. At what angle θ, distance between two planes for first-order reflection is equal to wavelength
   (a) 45° (b) 30° (c) 60° (d) 90°
5. At what angles for the first order diffraction, spacing between two planes respectively are λ and $\frac{\lambda}{2}$?
   (a) 0°, 90° (b) 90°, 0° (c) 30°, 90° (d) 90°, 30°.
6. The correct order of intensity of various potassium halides from (111) reflection is:
   (a) KF > KCl > KBr > KI (b) KF ≃ KCl ≃ KBr ≃ KI
   (c) KF < KCl < KBr < KI (d) KCl < KF < KBR < KI
7. As each set of lattice points can give rise to diffracted beam. The correct statement regarding the intensity of diffracted beam is:
   (a) The intensity of beams diffracted by certain sets of lattice points may be zero.
   (b) Intensity of diffracted beam is always greater than zero.
   (c) Intensity of diffracted beam is always zero.
   (d) All of the above.
8. The correct rule for reflection to be observed for a side centred cubic lattice:
   (a) All h, k, l are allowed (b) Sum of h, k s l should be even
   (c) Sum of h, k and l should be odd. (d) Sum of h and k should be even.
9. The interplanar spacing d_{110} in a BCC vanadium metal is 2.15Å. What is its lattice constant?
   (a) 3.04 Å (b) 5.11 Å (c) 7.12 Å (d) 1.23 Å
10. The X-rays of wavelength 0.5Å are diffracted at glancing angle of 5° from the crystal planes & first order diffraction occur. Find out the spacing between the corresponding adjacent planes of the crystal.
    (a) 2.87 Å (b) 1.82 Å (c) 3.11 Å (d) 4.33 Å

QUANTA POINT

11. X-rays wavelength 1.54 nm strike on aluminium crystal; the rays are reflected at an angle of 19.3°. Assuming that n = 1, calculate the spacing between the planes of aluminum atoms that is responsible for this angle of reflection. (sin 19.3 = 0.3305)

(a) 2.33Å (b) 4.52Å (c) 1.76Å (d) 3.12Å

12. For identical experimental conditions, the first-order Braggs reflection from a plane of a cubic crystal comes upto angle of 30° to 25°, respectively at 40°C and 50°C, respectively. Calculate the coefficient of cubic expansion of solid.

(a) 0.0182 K^{-1} (b) 0.0546 K^{-1} (c) 0.120 K^{-1} (d) 0.0345 K^{-1}

13. Gold crystallises in a fcc unit cell. The second order reflection from (100) plane occurs at $\theta = 22.2°$. If wavelength of the light used is 154 pm then density of metallic gold is

(Au = 197, $\sin\theta = 0.378$)

(a) 9.68×10^{-3} cm^{-3} (b) 4.84×10^{-3} cm^{-3} (c) 15.21×10^{-3} cm^{-3} (d) 19.36×10^{-3} cm^{-3}

14. Angle at which second-order diffraction will occur in an X-ray spectrometer when X-rays of 200 pm are diffracted by the atoms of a crystal having distance between the two planes as 400 pm is

(a) 90° (b) 60° (c) 45° (d) 30°

15. The diffraction of barium with X-radiation of wavelength 229 pm given a first-order diffraction at 30°. Thus, distance between the two planes is

(a) 114.5 pm (b) 229 pm (c) 458 pm (d) 200 pm

16. The unit cell dimension of NaCl lattice is 6.15Å. If an X-ray beam of wavelength of 1.1Å falls at 90°, on a family of planes with a separation of $\frac{a}{\sqrt{5}}$, find out the maximum number of order of diffraction that are observable.

(a) 2 (b) 3 (c) 4 (d) 5

17. The experimental results from Braggs method shows that, the first order reflection maxima occurs at 5.9°, 8.4° and 5.2° for (100), (110) and (111) planes respectively. Find the ratio of $d_{100} : d_{110} : d_{111}$. [Hint: sin 5.9° = 0.1028 sin 8.4 = 0.1461 sin 5.2 = 0.0906]

(a) $1 : \frac{1}{\sqrt{2}} : \frac{2}{\sqrt{3}}$ (b) $\frac{1}{\sqrt{2}} : 1 : \frac{2}{\sqrt{3}}$ (c) $\frac{1}{\sqrt{2}} : \frac{2}{\sqrt{3}} : 1$ (d) $\frac{2}{\sqrt{3}} : 1 : \frac{1}{\sqrt{2}}$

Numerical Answer Type (NAT)

18. Determine the angle through which an X-ray of wavelength of 0.440Å be reflected from the cube face of a rocksalt crystal (d = 2.814Å)

19. Electrons are accelerated by 344 volt and are reflected from a crystal. The first reflection maximum occurs when the glancing angle is 60°. Determine the spacing of the crystal?

20. A beam of X-rays incident on a sodium chloride crystal (lattice spacing 0.282 nm). The first order Bragg reflection is observed at a glancing angle of 8.35′. What is the wavelength of X-ray? [Hints: $\sin 8°35' \approx 0.1492$]

QUANTA POINT

DPP- (10) Solid State

Multiple Choice Questions (MCQs)

1. Calculate the lattice energy of some metal hallide, MX, given the following values
   Heat of formation = – 500 kJ
   Electron Affinity = – 400 kJ
   Ionization Energy = + 700 kJ
   Dissociation Energy = 300 kJ
   Sublimation Energy = 550 kJ
   (a) –1500 kJ (b) +1500 kJ (c) –1780 kJ (d) +1780 kJ
2. A reaction's heat of formation is
   (a) The amount of energy needed to add an electron to an atom or ion
   (b) The total change in energy when a compound is assembled from its element
   (c) The amount of energy needed to remove an electron from an atom
   (d) The amount of energy needed to form a ionic compound freom gaseous ions

   Common Data for Q3 and 4: The metal hallide can be arranged in the following order from smallest to largest ionic radies; LiCl, NaCl, KCl, RbCl or CsCl?
3. Which of the following has largest lattice energy
   (a) LiCl (b) NaCl (c) KCl (d) CsCl
4. Which of the following has smallest lattice energy?
   (a) LiCl (b) NaCl (c) KCl (d) RbCl
5. Which one of the following has greatest lattice energy?
   (a) MgO (b) NaCl (c) LiCl (d) $MgCl_2$
6. Calculate the lattice energy of NaCl using the following given data
   A = 1.747; r_{NaCl} = 282 pm
   (a) –756 kJ/mol (b) 756 kJ/mol (c) –427 kJ/mol (d) 427 kJ/mol
7. Calculate the lattice energy of CsCl using Born Lande equation given lattice parameter of CsCl unit cell is 412.3 pm.
   Madelung constant 1.763, and Born Exponent = 13.7 pm
   (a) +708 kJ/mol (b) –708 kJ/mol (c) 295 kJ/mol (d) –295 kJ/mol
8. Calculate alttice energy of CsCl using Kapustinskii equation given lattice parametre a = 412 pm
   (a) 304 kJ/mol (b) 608 kJ/mol (c) –304 kJ/mol (d) –608 kJ/mol
9. Estimate the lattice energy of CsCl using Born Hable cycle given
   Heat of formation of (SClCs) = – 433 kJ/mol
   Sublimation energy of Cs(s) = 79 kJ/mol

QUANTA POINT

Ionization energy of Cs(g) = 375 kJ/mol

Bond dissociation energy of $Cl_2(g)$ = 242 kJ/mol

Electron gain enthalpy of Cl(g) = – 349 kJ/mol

(a) 659 kJ/mol (b) 375 kJ/mol (c) –659 kJ/mol (d) –375 kJ/mol

10. Using the data, find out, out of NaCl and AgCl which is more ionic?

	Lattice Energy	Born Habler	Born Lande
	NaCl	787	751
	AgCl	915	734

(a) NaCl (b) AgCl

(c) Both are having same ionic character (d) Cannot be predicted

11. Using Kapustinskii equation calculate the lattice energy of Na_2CO_3.

given r_{Na^+} = 116 pm $r_{Co_3^{2-}}$ = 185 pm

(a) –2121.38 kJ/mol (b) –2121.38 J/mol (c) +2121.38 kJ/mol (d) +2121.38 J/mol

Numerical Answer Type (NAT)

12. Using Kapustinskii equation calculate lattice energy of $MgSO_4$ given $r_{Mg^{2+}}$ = 86 pm

$r_{SO_4^{2-}}$ = 230 pm

13. Using the following data calculate the electron gain enthalpy of chlorine

$\Delta H_{sublimation}$ of Mg = 148 kJ/mol

Heat of formation = –641 kJ/mol

First Ionization Energy = 738 kJ/mol

Second Ionization Energy = 1451 kJ/mol

Dissociation Energy of Cl_2 = 242 kJ/mol

Lattice Energy = –2526 kJ/mol

14. Using the Kapustinskii equation and the Born – Haber cycle with the following data for MgO (in kJ mol^{-1}), estimate the electron affinity for oxygen (O/O^{2-}): $S_{Mg} = 148$; $IP_{Mg/Mg^{2+}} = 2188$; $D_{O_2} = 498$; $\Delta H_{fMgO} = -602$; $r_{Mg^{2+}} = 0.86$ Å; $r_{O^{2-}} = 1.26$ Å

QUANTA POINT

DPP- (11) Solid State

Multiple Choice Questions (MCQs)

1. Cations are present in the interstitial sites in

   (a) Frenkel defect (b) Schottky defect

   (c) vacancy defect (d) metal deficiency defect

2. Select the correct statement(s) about non-stoichiometric compounds.

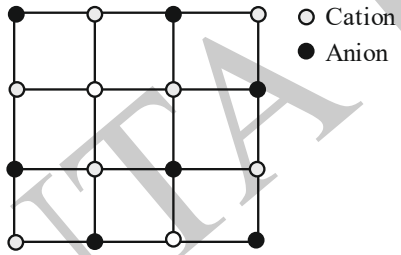
   (a) They are called berthollide compounds

   (b) They do not obey the law of constant composition

   (c) Electrical neutrality is maintained either by having extra electrons in the structure in the structure or by changing the charge on some of the metal ions

   (d) All of the above

3. Structure shown in the figure represent



   (a) Schottky defect (b) Frenkel defect (c) metal excess defect (d) None of these

4. Which of the following defects is also known as dislocation defect

   (a) Frenkel (b) Schottky

   (c) Non-stoichiometric (d) Simple interstitial

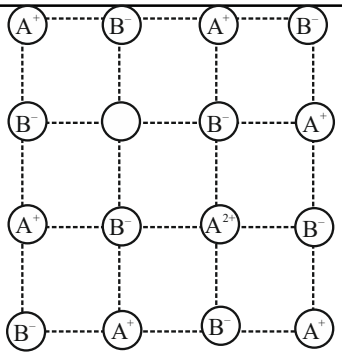
5. Calcium crystallises in a fcc unit cell with a = 0.556 nm. IT contained 0.1%. Frenkel defect and 0.1% Schottky defect. Density with Frenekel defect= d_f and density with Schottky defect = d_s , then

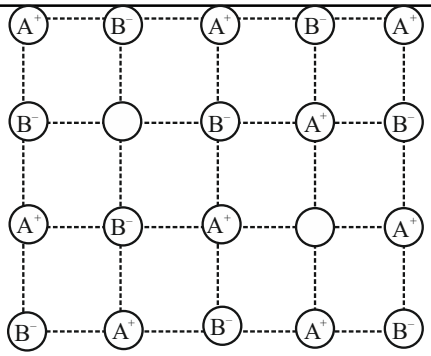
   (a) $d_f = d_s$ (b) $d_f > d_s$

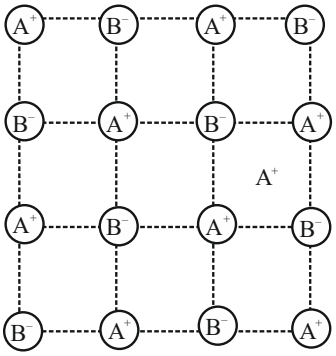
   (c) $d_f < d_s$ (d) density is not concerned with defect

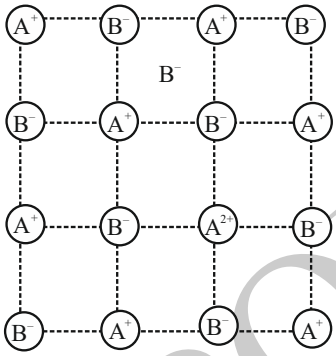
6. Which of the following represents incorrect defect in crystals?

QUANTA POINT

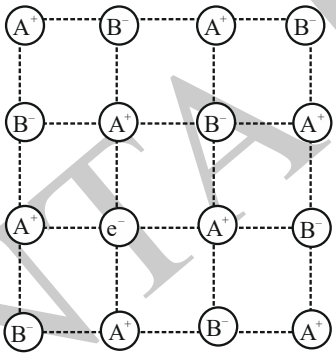
(a) 

(b) 

(c) 

(d) 

7. Select the correct statement(s) about the given structure



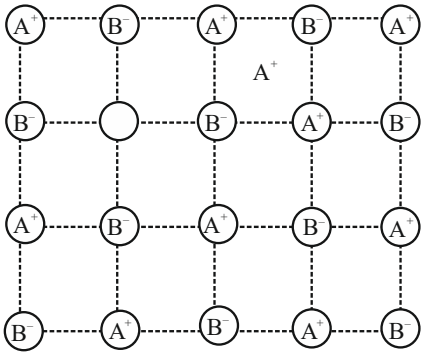
(a) This represents metal excess defect and is formed by crystals which would be expected to form Schottky defect

(b) Anion sites occupied by electrons are called F-centres

(c) These are paramagnetic in nature

(d) All of the above

8. Select the correct statement(s) about following structure.



(a) It represents Frenkel defect

(b) Cation is smaller than anion and there is probability that cations occupy interstitial positions

QUANTA POINT

(c) Due to the large difference in size of cation and anion, coordination number is usually low

(d) All of the above

9. Which type of defect has the presence of cations in the interstitial site?

(a) Schottky defect (b) Frenkel defect

(c) Metal deficiency defect (d) valency defect

10. Assertion: Most of the compound has both Schottky defect and Frenkel defect.

Reason: Both defect decreases density.

(a) Both assertion and Reason are correct, and reason is correct explanation of assertion.

(b) Both assertion and reason are correct and reason is not correct explanation of assertion.

(c) Assertion is incorrect, reason is correct

(d) Both assertion and reason are incorrect.

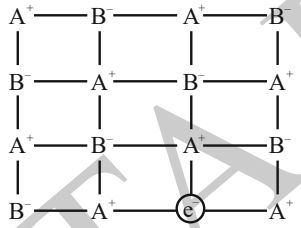
11. Statement-I: Due to Frenkel defect, there is no effect on density of the crystalline solid.

Statement-II: In Frenkel defect, no cation or anion leaves the crystal.

Which of the statement is/are correct

(a) I (b) II (c) Both I and II (d) None

12. The picture shown in the figure shows which defect.



(a) Metal excess defect (b) Metal deficiency defect

(c) Impurity defect (d) None of these

13. The electron trapped in the anionic valency are known as

(a) E-centre (b) Cr-Centre (d) F-Centre (d) None of the above

14. In a crystal, if fault exist in the arrangement along the surface is called.

(a) Surface defect (b) point defect (c) line defect (d) None

15. The correct statement regarding F-centre is

(a) Electron held in the void of the crystal

(b) F-centre produces colours to the crystal

(c) Conductivity of the crystal increase due to F centre

(d) All

Multiple Select Questions (MSQs)

16. Which of the following defects decrease density of the lattice?

(a) Interstitial (b) Vacancy (c) Frenkel (d) Schottky

17. Select the correct statement(s).

(a) Frenkel defects do not change the value of the theoretical density

(b) Schottky defects do not change the value of theoretical density

(c) Schottky defects change the value of theoretical density

(d) A defects of 0.1% decreases value of z by 0.1.

QUANTA POINT

Numerical Answer Type (NAT)

18. Calcium crystallises in a face-centred cubic unit cell with a = 0.556 nm. If the sample of calcium contained 0.1% Schottky defects in the crystal, what is the density.

19. If an element (at. wt. = 50) crystallises in fcc lattice, with a = 0.50 nm. What is the density of unit cell if it contains 0.25% Schottky defects (use $N_A = 6 \times 10^{23}$)?

QUANTA POINT

DPP- (12) Solid State

Multiple Choice Questions (MCQs)

1. According to band theory of solids, why is lead a good conductor
   (a) small energy gap between valence band and conduction band
   (b) large energy gap between valence band and conduction band
   (c) completely filled valence band
   (d) Overlapping of conduction band and valence band
2. In conductor conductivity increases as ____.
   (a) temperature decreases
   (b) the applied electrically field decreases
   (c) resistance increases
   (d) more electrons move to valence band
3. At OK, the fermi level of n-type semiconductor lies at
   (a) conduction band
   (b) Donor band
   (c) Between conduction band and donor band
   (d) Valence band
4. at 0K, the fermi level of p-type semiconductor lies at
   (a) conduction band
   (b) Donor band
   (c) Between conduction band and donor band
   (d) Valence band
5. Arrange the forbidden energy gap of conductor, insulator and semiconductor
   (a) $E_{conductor} < E_{semiconductor} > E_{insulator}$
   (b) $E_{insulator} > E_{conductor} > E_{semiconductor}$
   (c) $E_{insulator} > E_{semiconductor} > E_{conductor}$
   (d) $E_{semiconductor} > E_{insulator} > E_{conductor}$
6. Select the correct statement(s).
   (a) Electronic conductors are classified as metallic conductors or semiconductors according to the temperature dependence of their conductivities.
   (b) A superconductor is an electronic conductor with zero resistance
   (c) Both of the above are correct
   (d) None of the above is correct
7. According to the band theory
   (a) electrons occupy molecular orbitals formed from the overlap of atomic orbitals
   (b) filled bands are called conduction bands

QUANTA POINT

(c) empty bands are called valence bands

(d) All of the above

8. Semiconductors are classified as

(a) p-type when conduction is due to holes in the valence band

(b) n-type when conduction is due to electrons in the conduction band

(c) Both of the above are correct facts

(d) None of the above is correct fact

9. A bulk sample exposed to a magnetic field H acquires a magnetisation M = XH (where X is the dimensionless volume magnetic susceptibility). Thus

(a) when $X < 0$, the material is diamagnetic and moves out of a magnetic field.

(b) when $X > 0$, the material is paramagnetic and moves into a magnetic field.

(c) Both of the above

(d) None of the above

10. Out of V_2O_5 and CoO,

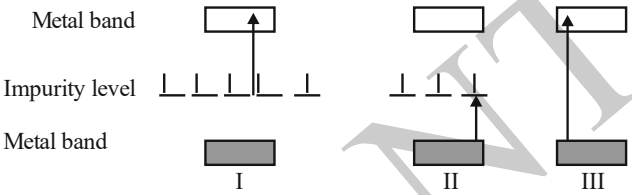
(a) V_2O_5 forms n-type and CoO forms p-type semiconductor

(b) V_2O_5 forms n-type and CoO forms n-type semiconductor

(c) Both from n-type semiconductor

(d) Both from p-type semiconductor

11. Consider the following energy diagram.



These energy diagrams are respectively, for semiconductors.

	I	II	III
(a)	n-type	p-type	Intrinsic
(b)	n-type	Intrinsic	p-type
(c)	p-type	Intrinsic	n-type
(d)	p-type	n-type	Intrinsic

12. On heating, which is not observed

(a) ferrimagnetic substances lose ferrimagnetism and become paramagnetic

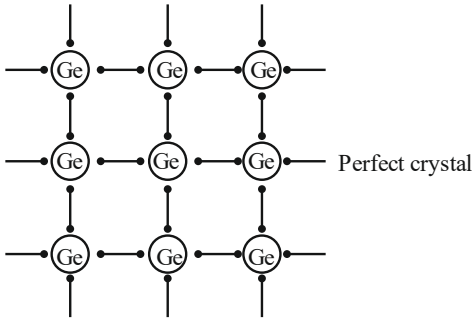
(b) ferrimagnetic substances do not lose ferrimagnetism and remain ferrimagnetic

(c) a small electronic current is produced in polar crystal (pyroelectricity)

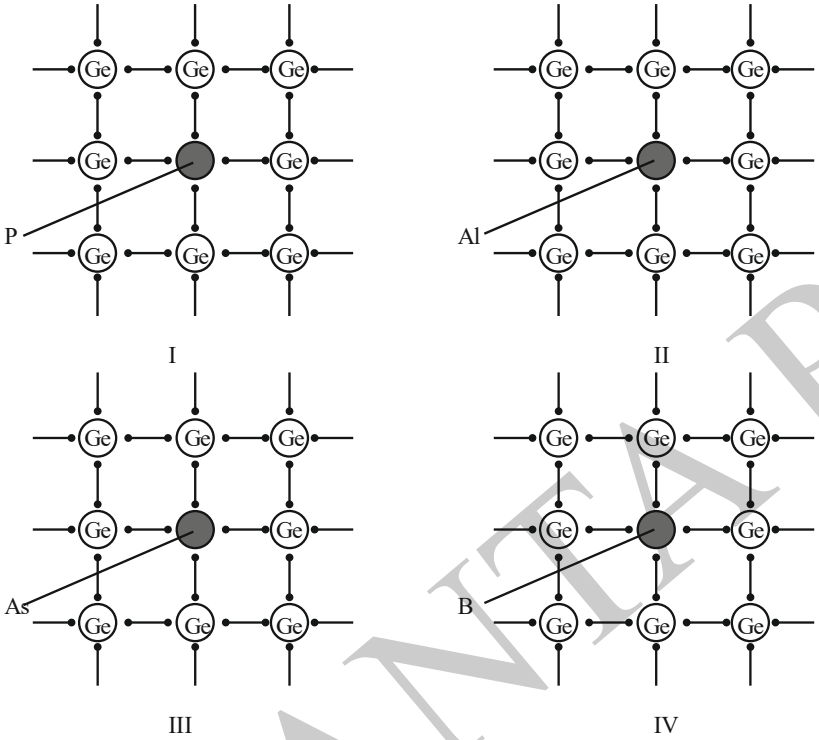
(d) 6 : 6 of NaCl coordination changes to 8: 8 coordination

13. Germanium has been doped with impurity as shown in I, II, III and IV and based as it statements (A) to (D).

QUANTA POINT



are given



A = n-type semiconductor is formed in I and III

B = p-type semiconductor is formed in II and IV

C = n-type semiconductor is formed in II and IV

D = p-type semiconductor is formed in I and III

Select the correct statement(s)

(a) A, B (c) C, D (c) A, D (d) A, B, C

14. In an insulating material, _____

(a) the valence band is filled and conduction band is empty.

(b) the valence band is empty and the conduction band is filled

(c) both the valence bond and conduction bond are empty

(d) None

15. A material with 10eV forbidden energy gap is

(a) conduction (b) insulator (c) semiconductor (d) isolated atom

QUANTA POINT

16. A material with a relatively large gap between its valence band and conduction band would be expected to be
(a) a good conductor (b) easily melted (c) a poor conductor (d) crystalline materials

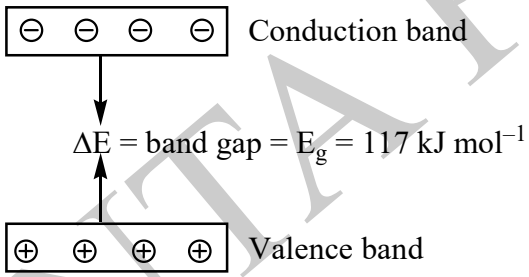
Multiple Select Questions (MSQs)

17. Anti-ferromagnetic substances
(a) get oriented in the direction of the applied magnetic field
(b) get oriented opposite to the direction of the applied magnetic field
(c) are oppositely oriented with respect to each other without the application of the magnetic field
(d) cancel out each other magnetic moment

18. Select the correct statement(s) about the movement of electrons and holes in a p-type semiconductor when an electric field is applied.
(a) Electron will move towards positively charged plate through electronic holes
(b) Holes will appear to be moving towards the negatively charged plate
(c) Both electrons and holes appears to move towards the positively charged plate
(d) neither electrons nor holes move

Numerical Answer Type (NAT)

19. For silicon, given



Wavelength of light that can excite an electron from the valence band to the conduction band in silicon is

20. What is the approximated energy gap between the valence band and conduction band of insulator?

QUANTA POINT

DPP-(13) Solid State

Multiple Choice Questions (MCQs)

1. CdO has NaCl structures with density 8.27 g/cc. If the ionic radius of O^{2-} is 1.24Å, determine ionic radius of Cd^{2+}.

   (a) 1.5 Å (b) 1.1 Å (c) 1.9Å (d) 1.5 Å

2. Ferrous oxide has a cubic structure and edge length of the unit cell is 5.0Å. Assuming the density of ferrous oxide to be 3.84 g/cm^3, the no. of Fe^{2+} and O^{2-} ions present in each unit cell be: (use $N_A = 6 \times 10^{23}$)

   (a) 4 Fe^{2+} and 4 O^{2-} (b) 2 Fe^{2+} and 2 O^{2-} (c) 1 Fe^{2+} and 1 O^{2-} (d) 3 Fe^{2+} and 4 O^{2-}

3. What is the percent by mass of titanium in rutile, a mineral that contain Titanium and oxygen, if structure can be described as a closest packed array of oxide ions, with titanium in one half of the octahedral holes.

   (a) 40% (b) 60% (c) 70% (d) 92%

4. Spinel is a important class of oxides consisting of two types of metal ions with the oxide ions arranged in CCP pattern. The normal spinel has one-eight of the tetrahedral holes occupied by one type of metal ion and one half of the octahedral hole occupied by another type of metal ion. Such a spinel is formed by Zn^{2+}, Al^{3+} and O^{2-}, with Zn^{2+} in the tetrahedral holes. Give the formulae of spinel.

   (a) $ZnAl_2O_4$ (b) $ZnAl_2O_3$ (c) $ZnAl_2O_2$ (d) $ZnAlO_2$

5. Which of the following statements is/are incorrect regarding NH_4CN crystal structure?

   (a) NH_4CN has distorted CsCl structure

   (b) In NH_4CN, $CN^{\ominus}$ ions assume spherical symmetry.

   (c) NH_4CN crystallizes to tetragonal crystal system.

   (d) $CN^{\ominus}$ ions are oriented parallel to face diagonal

6. In SnO, coordination number of Sn^{2+} is:

   (a) 4 (b) 6 (c) 8 (d) 12

7. Perovskite, a mineral containing calcium, oxygen and titanium crystallises in the given cubic unit cell. What is the oxidation number of titanium?

   (a) 6 (b) 4 (c) 8 (d) 2

8. Boron phosphide (BP) is a semiconductor and a hard, abrasion-resistance material. It crystallises in a zinc blende structure, formed from boron atoms in a fcc lattice and phosphorus atoms in tetrahedral holes. Thus, phosphorus atoms occupies

   (a) $\frac{1}{2}$ of the tetrahedral holes (b) $\frac{1}{8}$ of the octahedral holes

   (c) $\frac{1}{8}$ of tetrahedral holes (d) equal to tetrahedral holes

9. Unit cell of $(BN)_n$, i.e. boron nitride, is smaller to that of graphite except that each layer consists of alternating B

QUANTA POINT

and N-atoms in hexagonal rings. It crystallises in a hexagonal unit cell with a = 0.251 nm, z = 2 for $(BN)_n$. For graphite, a = 0.2455 nm and distance bteween C-atoms = 0.1415 nm. Thus, distance between B and N-atoms is

(a) 0.1415 nm (b) 0.2500 nm (c) 0.1450 nm (d) 0.1250 nm

10. Among the following which packing describes the arrangement of oxide ions in rutile structure.

(a) Hexagonal close packing (b) Cubic close packing

(c) Tetragonal packing (d) Orthogonal packing

11. The correct statement regarding Cs_2O lattice structure is:

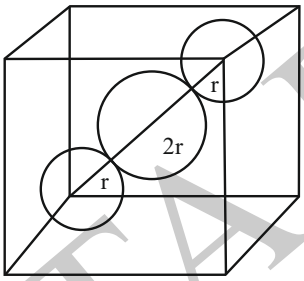
(a) In Cs_2O lattice, is forms hcp layersand'O' occupies the octahedral sites between alternate pairs of Cs layers.

(b) Cs form ccp layers and 'O' occupiesthe octahedral sites.

(c) Cs forms ccp layers and 'O' occupies alternate octahedral sites.

(d) Cs form hcp layersand 'O' occupies all tetrahedral sites.

12. Iron crystallises in several modifications. At about 910°C, 'bcc' from (called α-form) undergoes transition to γ-form with 'fcc' lattice. Assuming that the distance between the nearest neighbours is the same in the two forms at the transition temperature, calculate the ratio of the density of γ-iron at the transition temperature.



(a) 1 (b) 1.5 (c) 2 (d) 2.5

13. Which statement describes the formal relation between rock salt and perovskite structure?

(a) In both structures, Na and Ti cations occupies tetrahedral sites.

(b) In both rock salt structure and pervoskite structure, all octahedral sites are occupied

(c) In NaCl, all octahedral sites are occupied and in pervoskite, one quarter of the octahedral sites are occupied.

(d) In NaCl, Na occupies octahedral sites and Ti occupies half tetrahedral sites.

Multiple Select Questions (MSQs)

14. Among the following statements, the correct statements regarding $CdCl_2$ and CdI_2 structure is/are:

(a) In $CdCl_2$, Cl^- ions are in ccp while in CdI_2, I^- arranges in hcp arrangement.

(b) In both $CdCl_2$ and CdI_2 structure, Cd^{2+} ions are sandwiched between layers of anions.

(c) In both $CdCl_2$ and CdI_2, anions are arranged in hcp arrangement.

(d) All of the above

QUANTA POINT

Solid State

ANSWER KEY

DPP-1

1.	(d)	2.	(d)	3.	(d)	4.	(a)	5.	(b)	6.	(a)	7.	(d)
8.	(c)	9.	(c)	10.	(d)	11.	(b)	12.	(d)	13.	(a)	14.	(b)
15.	(c)	16.	(a,b,c)	17.	(a,b,c)	18.	(9)	19.	(3)	20.	1.732Å		

DPP-2

1.	(c)	2.	(c)	3.	(c)	4.	(c)	5.	(d)	6.	(b)	7.	(d)
8.	(c)	9.	(c)	10.	(c)	11.	(a)	12.	(a)	13.	(a)	14.	(c)
15.	(d)	16.	(3)	17.	(3)								

DPP-3

1.	(b)	2.	(d)	3.	(a)	4.	(b)	5.	(a)	6.	(c)	7.	(c)
8.	(c)	9.	(b)	10.	(d)	11.	(d)	12.	(b)	13.	(b)	14.	(a)
15.	(a)	16.	(d)	17.	(b)	18.	231.2pm		19.	123.84pm			
20.	175.8pm												

DPP-4

1.	(c)	2.	(a)	3.	(b)	4.	(c)	5.	(d)	6.	(a)	7.	(d)
8.	(a)	9.	(a)	10.	(c)	11.	(c)	12.	(a)	13.	(b)	14.	(b)
15.	(c)	16.	(a,b,c)	17.	(a,c)	18.	(0.24%)	19.	(79.3%)	20.	(117.1pm)		

DPP-5

1.	(a)	2.	(a)	3.	(a)	4.	(c)	5.	(a)	6.	(d)	7.	(b)
8.	(a)	9.	(b)	10.	(b)	11.	(a)	12.	(b)	13.	(a)	14.	(b)
15.	(a)	16.	(b,c,d)	17.	(b,c,d)	18.	(6)	19.	(43.875pm)		20.	(216pm^3)	

DPP-6

1.	(a)	2.	(a)	3.	(c)	4.	(c)	5.	(d)	6.	(c)	7.	(b)
8.	(a)	9.	(c)	10.	(a)	11.	(b)	12.	(a)	13.	(b)	14.	(c)

QUANTA POINT

15. (b) 16. (a,c,d) 17. (d) 18. (125 pm) 19. (6) 20. (100%)

DPP-7

1. (a) 2. (c) 3. (d) 4. (b) 5. (a) 6. (d) 7. (b)
8. (a) 9. (c) 10. (d) 11. (a) 12. (a) 13. (a) 14. (c)
15. (b) 16. (a,b,d) 17. (a,b) 18. (144.3pm) 19. (37.63gmol^{-1})
20. (12.71 g cm^{-3})

DPP-8

1. (a) 2. (c) 3. (b) 4. (b) 5. (c) 6. (a) 7. (a)
8. (c) 9. (d) 10. (a) 11. (c) 12. (a) 13. (c) 14. (d)
15. (c) 16. (c) 17. (a,b) 18. (1.3Å) 19. (109.5°) 20. (35.27°)

DPP-9

1. (c) 2. (a) 3. (a) 4. (b) 5. (c) 6. (d) 7. (a)
8. (a) 9. (a) 10. (a) 11. (a) 12. (b) 13. (d) 14. (d)
15. (b) 16. (d) 17. (a) 18. (4.5°) 19. (0.38Å) 20. (0.8414Å)

DPP-10

1. (a) 2. (b) 3. (a) 4. (d) 5. (a) 6. (a) 7. (b)
8. (d) 9. (a) 10. (a) 11. (a) 12. (-2707.7 kJ/mol)
13. (–347 kJ/mol) 14. (606 kJ/mol)

DPP-11

1. (a) 2. (d) 3. (a) 4. (a) 5. (b) 6. (d) 7. (d)
8. (d) 9. (b) 10. (d) 11. (c) 12. (a) 13. (c) 14. (a)
15. (d) 16. (b,d) 17. (a,c) 18. (1.5448g cm^{-3}) 19. (2.66 g/cc)

DPP-12

1. (d) 2. (a) 3. (a) 4. (b) 5. (c) 6. (c) 7. (a)
8. (c) 9. (c) 10. (a) 11. (a) 12. (b) 13. (a) 14. (a)
15. (c) 16. (c) 17. (c,d) 18. (a,b) 19. (1022 nm) 20. (10eV)

DPP-13

1. (b) 2. (a) 3. (b) 4. (a) 5. (b) 6. (a) 7. (b)
8. (a) 9. (c) 10. (c) 11. (b) 12. (a) 13. (c) 14. (a,b)

QUANTA POINT